AD-A010 601

EVALUATING A MAGNESIUM-AMMONIUM PHOSPHATE SUSPENSION AS A FERTILIZER MATERIAL

Eldon L. Hood

Purdue University

Prepared for:

Naval Ammunition Depot

12 December 1974

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE

168083

RDTR NO. 283

ADA010601

EVALUATING A MAGNESIUM-AMMONIUM PHOSPHATE SUSPENSION AS A FERTILIZER MATERIAL

Eldon L. Hood
Department of Agronomy
Purdue University
West Lafayette, Indiana 47907

12 December 1974

Interim Report for Period March - October 1974

APPROVED FOR PUBLIC RELEASE; DISTRIBUTION UNLIMITED

Prepared for
Commander
NAVAL SEA SYSTEMS COMMAND
Washington, D. C. 20362

Commanding Officer
NAVAL AMMUNITION DEPOT
Applied Sciences Department
Crane, Indiana 47522

29

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER RDTR No. 283	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) EVALUATING A MAGNESIUM-AMMONIUM PHOSPHATE SUSPENSION AS A FERTILIZER MATERIAL		5. TYPE OF REPORT & PERIOD COVERED Interim March to October 1974
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Eldon L. Hood		8. CONTRACT OR GRANT NUMBER(s) N00024-75-WR-52226
9. PERFORMING ORGANIZATION NAME AND ADDRESS Department of Agronomy Purdue University West Lafayette, Indiana		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS SF57572, SF57572301 Work Unit No. 1 62765
11. CONTROLLING OFFICE NAME AND ADDRESS Naval Sea Systems Command (SEA-0332) Washington, D. C. 20362		12. REPORT DATE 12 December 1974
		13. NUMBER OF PAGES 29
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) Naval Ammunition Depot Applied Sciences Department Crane, Indiana 47522		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

JPAD, Red Phosphorus, Soil Additive, Magnesium Ammonium Phosphate (MAP), Pyrotechnics, Waste Disposal, Triple Superphosphate

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This paper reports an experiment which used a soil additive made from waste red phosphorus compositions to evaluate it's potential as a nitrogen and phosphorus carrier. The experiment was conducted at the Southern Indiana Purdue Agricultural Center, Dubois, Indiana. The soil type is Zanesville silt loam, with good surface drainage and poor internal drainage due to compacted (fragipan) clay layer in the subsoil. The soil pH was tested at 6.2-6.5 with low phosphorus and medium potassium contents. A

DD FORM 1473, 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE
S/N 0102-014-6601

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered) split plot design was selected assigning the two fertilizer materials--Triple Superphosphate (TSP), a commercial one, and Magnesium Ammonium Phosphate (MAP), which was made from waste red phosphorus compositions--to main blocks and rates randomly assigned to subplots. Four replications comprise the study for fescue grass with each subplot measuring five by eight feet, or approximately 0.001 acre. The phosphorus content of the additive and the commercial is 3.78% and 19.78% respectively, and the treatment rates for the fescue grass was 0 to 240 pounds per acre, and 0 to 300 pounds per acre for the alfalfa crop which was laid out in three replicates. The fescue grass was treated on 20 March 1974 and was checked in mid May and July for flowering, stem, and leaf growth. On both occasions, normal growth was observed. The fescue grass plot was over seeded with Korean Lespedeza, a legume which has a quantitative requirement for phosphorus. Checking for the growth rate of this legume, we discovered that the nitrogen content of the soil additive was such that extreme basal growth occurred which inhibited the growth of the legume. The alfalfa plot was initiated in mid July, and one month later the crop was observed for normal development. At that time, all growth traits were normal. As it turned out in the soil additive for every 60 pounds of phosphorus applied we benefitted with 27 pounds of nitrogen. So, the nitrogen rate was 0-108 pounds per acre. The difference between the subplots can be attributed to the nitrogen content of the soil additive (MAP). The legume seedling counts were doubled for the TSP compared to MAP at 1.07 to .55 for the July stand, and tripled .48 to .15 for the September stand for tall fescue grass. For the alfalfa crop, a complete evaluation cannot be made due to other deficiencies, namely calcium, magnesium, copper, and boron which are needed to obtain a true response to MAP treatment.

Table of Contents

	Page
Tall Fescue	
Introduction	1.
Procedures	2.
Figure 1. Experimental Plot Diagram	3.
Results	4.
Table 1. Plant Height Data	5.
Table 2. Legume Seedling Counts	6.
Plant Analyses	7.
Table 3. Plant Tissue Analyses by Sampling Dates	8.
Table 4. Plant Tissue Analyses, May 24, 1974	9.
Table 5. Plant Tissue Analyses, July 14, 1974	10.
Table 6. Plant Tissue Analyses, October 10, 1974	11.
Soil Analyses	12.
Table 7. Soil Test Data - pH, P, K	13.
Table 8. Soil Test Data - Mg, Mn, Zn	14.
Summary	15.
Alfalfa	16.
Procedures	16.
Figure 1. Experimental Plot Diagram	18.
Results	19.
Plant Analyses	19.
Soil Tests	19.
Table 9. Plant Analysis Data	20.
Table 10. Soil Phosphorus Tests	21.
Table 11. Soil Test Data - pH, K	23.
Table 12. Soil Test Data - Mg, Mn, Zn	24.
Summary	25.

Submitted

B. E. DOUDA, Manager
Chemical Sciences Branch
Pyrotechnic Division
Applied Sciences Department

Evaluating a Magnesium-Ammonium Phosphate Suspension as a Fertilizer Material on Tall Fescue

Phosphorus as an essential element for plant growth is currently in short supply for meeting the demands of American agriculture. Because of this shortage, it is most opportune for salvageable materials to be returned to useful channels, if at all possible.

With this background, a magnesium-ammonium phosphate suspension was received from the Crane Depot for field testing at Southern Indiana Purdue Agricultural Center, east of Dubois, Indiana, in Dubois County.

While considering this product for crop use, it was imperative that an evaluation be obtained as soon as possible, therefore, requiring an established crop. Since tall fescue sod on low fertility soil was available, an experimental study was initiated on March 20, 1974.

Objectives of the study were as follows:

1. Compare magnesium-ammonium-phosphate (MAP) with a standard granular fertilizer such as triple superphosphate (TSP) for their plant feeding properties.
2. Evaluate both materials over a wide range of treatment rates.
3. Observe the capacity of these materials to stimulate legume seedlings in an established grass sod.
4. Investigate nutrient uptake by the growing crop as measured by plant tissue analyses.
5. Examine changes in soil fertility levels as affected by rate and source of phosphorus carrier.

PROCEDURES

The following abbreviated details describe the study in progress:

Location - Southern Indiana Purdue Agricultural Center, Dubois, Indiana.

Soil Type - Zanesville silt loam, good surface drainage with 2% slope; internal drainage is poor, due to compacted (fragipan) clay layer in subsoil.

Soil Test Data - pH 6.2 to 6.5; Phosphorus - 4 to 6 ppm (very low); Potassium - 130 ppm (medium).

Experimental Design - split plot (phosphorus carriers assigned to main plots).

Plot Size - 5 feet by 8 feet, .001 A.

Replications - four (see Figure 1).

Treatments - Magnesium-ammonium-phosphate (3.78% P), suspension

Triple superphosphate (19.78% P), granular.

Treatment Rates - 0 (check), 60, 120, 180, and 240 lbs. P_2O_5/A.

Date of Application: March 20, 1974.

The experimental site was selected on March 20, 1974, on an area which had no previous history of phosphorus fertilization. A blanket application of muriate of potash was applied to the experimental site prior to staking and outlining individual subplots.

A split plot design was selected assigning the two fertilizer materials to main blocks and rates randomly assigned to subplots. Four replications comprise the study with each subplot measuring five feet by eight feet, or approximately .001 acre.

E

B	B	B	B	B	A	A	A	A	A
0	180	60	240	120	60	0	120	240	180
A	A	A	A	A	B	B	B	B	B
180	240	0	120	60	60	180	240	0	120
B	B	B	B	B	A	A	A	A	A
240	120	0	60	180	180	240	120	0	60
A	A	A	A	A	B	B	B	B	B
0	60	120	180	240	0	60	120	180	240

N S

W

A - Magnesium ammonium phosphate

B - Triple superphosphate

Treatment Rates - 0 (check), 60, 120, 180, and 240 lbs. P_2O_5/A

igure 1. Experimental Plot Diagram for Magnesium-Ammonium-Phosphate Study on Established Fescue Sod.

Rates of phosphorus materials used are shown below:

lbs. P_2O_5/A	M-A-P Gms. Susp./plot	T-S-P Gms./plot
0 (check)	0	0
60	308	60
120	616	120
180	924	180
240	1230	240

Plots were outlined with cord and then staked in accordance with experimental diagram.

Treatments of magnesium-ammonium-phosphate were weighed on a gram scale and then diluted with water to a minimum of approximately three pounds. The suspension was then applied to a plot, using a garden sprinkler can.

A systematic pattern was followed by spreading the suspension lengthwise to a plot in broad sweeps until the area was initially covered and then returning to the first point of contact and repeating the process.

Triple superphosphate was weighed to the nearest gram according to plot requirements and then diluted with masonry sand to facilitate hand broadcasting.

After completion of phosphorus applications, Korean Lespedeza (Lespedeza stipulacea) was broadcast across the experiment at approximately 10 lbs/acre. This would allow approximately 70 seed per square foot, assuming uniform distribution with a cyclone (hand) seeder.

At the time of overseeding, new fescue growth had begun to appear thru the aftermath from the previous season. To an observer unfamiliar with legume-grass mixtures, this would appear to be excessive competition for small seedlings to emerge thru a residual mulch. However, it is not uncommon for Korean Lespedeza, a summer annual, once seeded to the land to continue to germinate annually and re-establish itself with a new seed crop. Phosphorus treatments would enhance the possibilities of legume establishment on this site.

Results

The plots were inspected on May 24 for phosphate response and legume emergence. All plots were in early flowering stage as evident from the fescue leaf and stem measurements in Table 1.

Because as much as 108 lbs. nitrogen was applied per acre on the 240 lb. MAP treatment, an extremely heavy basal growth developed.

Patterns of fertilizer movement were also evident across plot borders from the .53 inch of rainfall on March 21 after treatment applications on March 20.

Notes were taken recording these observations.

No effort was made to count legume seedlings on May 24, as it seemed more feasible for the top growth to be mowed and the aftermath removed before attempting a detailed count.

Table 1. Plant Height Data from Phosphorus Study on Tall Fescue Sod
Date: May 24, 1974

Treatment ($lbs.\ P_2O_5/A$)	Plant Part: Basal Leaf MAP	Basal Leaf TSP	Stem & Seed Head MAP	Stem & Seed Head TSP
	Height (in.)			
0	12	12	32	30
60	14	12	32	30
120	20	12	36	30
180	24	12	38	30
240	26	12	42	30

Observations: Basal leaf growth under MAP treatments was extremely heavy at the high rates, and became detrimental to lespedeza seedlings by mid-summer.

On June 13, the top growth still remained on the plots due to insufficient manpower during the hay season. It was therefore decided to wait until the first week of July to make the counts.

On July 2, evidence of nitrogen effect from 180 lb. and 240 lb. MAP treatments was still apparent. Plots were fairly uniform in height, yet irregular due to late cleanup.

Two plant counts using a foot square wire frame constituted the seedling counts within each plot. A random toss from an adjacent plot was used to locate the first site while a second toss from within the plot determined the second. Only legume plants rooted within the wire enclosure were included in the count.

Results of two counts completed on July 2 and September 17, are shown in Table 2. Treatment averages (5 treatments x 4 replications) show a pronounced

Table 2. Legume Seedling Counts from Phosphorus Study on Tall Fescue Sod

N (lbs/A) as MAP	Treatment (lbs. P_2O_5/A)	Date of Stand Counts: July 2, 1974		September 17, 1974	
		MAP	TSP	MAP	TSP
0	0	10	7	1	7
27	60	8	15	5	3
54	120	2	6	0	1
81	180	2	5	0	5
108	240	0	10	0	3
	Total	22	43	6	19
	Treatment average	1.1	2.15	0.3	0.95
	Plants/sq. ft.	0.55	1.07	0.15	0.48

reduction where nitrogen stimulated tall fescue competition and less legumes in contrast to an absence of nitrogen effect with TSP and a slightly better legume count.

Plant Analyses

Plant tissue samples, simulating hay removal, were collected on May 24, 1974, July 14, 1974, and October 10, 1974.

Initial spring harvest was more mature, as exemplified by plant height data at that time. Plant nitrogen approached 2% where MAP had been applied at the heaviest rate. Plots receiving only TSP applied were very N-deficient.

The second sampling on July 14, demonstrated a slight advantage for MAP in providing nitrogen for fescue in view of the heavy growth removed from the first harvest.

By the third sampling date, any residual nitrogen benefit from MAP had disappeared. Phosphorus levels were virtually the same for both materials after a considerable spread on the second cutting.

Other elements occurred at adequate concentrations in tall fescue tissue, except zinc. This element was marginal on both first and third cuttings, assuming 20 ppm to be adequate, regardless of phosphorus carrier and rate.

Table 3. Plant Tissue Analyses from Phosphorus Study Using Tall Fescue Sod

Nitrogen Treatment (lbs. P_2O_5/A)	lbs. N Applied/A		Sampling Dates: May 24, 1974 MAP	May 24, 1974 TSP	July 14, 1974 MAP	July 14, 1974 TSP	October 10, 1974 MAP	October 10, 1974 TSP
			% N					
0 (check)	0		1.33	1.40	2.02	1.94	1.61	1.60
60	12		1.50	1.32	1.94	1.98	1.61	1.57
120	24		1.51	1.31	2.00	1.92	1.59	1.58
180	36		1.71	1.46	2.04	1.98	1.60	1.68
240	48		1.88	1.47	2.08	1.98	1.54	1.60
		Av.	1.58	1.39	2.01	1.96	1.59	1.60
			% P					
0			.26	.32	.57	.47	.29	.31
60			.35	.35	.46	.63	.36	.43
120			.36	.29	.52	.79	.36	.43
180			.29	.31	.54	.81	.37	.43
240			.30	.40	.54	.88	.44	.47
		Av.	.31	.53	.52	.71	.36	.41
			% Mg					
0			.26	.36	.53	.46	.29	.33
60			.36	.28	.47	.55	.31	.35
120			.40	.28	.48	.59	.32	.32
180			.32	.27	.53	.55	.38	.29
240			.33	.22	.54	.57	.38	.32
		Av.	.33	.28	.51	.54	.33	.32
			Mn ppm					
0			108	177	210	149	85	66
60			185	154	165	191	78	66
120			192	177	172	217	66	75
180			213	142	317	208	116	70
240			156	78	262	202	124	82
		Av.	171	145	225	193	93	72

Table 4. Plant Analysis Data from Phosphorus Carrier Study on Tall Fescue for 1974*

Element	Carrier	Treatment (lbs. P_2O_5/A) 0	60	120	180	240	Optimum Lev (Percent)
		------- % -------					
Nitrogen	MAP	1.33	1.50	1.51	1.71	1.88	2.50
	TSP	1.40	1.32	1.31	1.46	1.47	
Phosphorus	MAP	.26	.35	.36	.29	.30	.35
	TSP	.32	.35	.29	.31	.40	
Potassium	MAP	2.26	2.48	2.39	2.63	2.35	2.00
	TSP	2.36	2.45	2.34	2.53	2.16	
Calcium	MAP	.32	.43	.51	.44	.40	.30
	TSP	.52	.34	.38	.43	.36	
Magnesium	MAP	.26	.36	.40	.32	.33	.20
	TSP	.36	.28	.28	.27	.22	
		------- ppm -------					
Manganese	MAP	108	185	192	213	156	50
	TSP	177	154	177	142	78	
Iron	MAP	66	92	101	75	72	50
	TSP	92	65	57	64	60	
Boron	MAP	9	11	12	9	9	6
	TSP	11	9	9	8	8	
Copper	MAP	6	7	9	6	7	3
	TSP	7	6	6	6	6	
Zinc	MAP	17	22	28	20	21	20
	TSP	20	17	16	15	14	

* Top growth collected on May 24, 1974

Table 5. Plant Analysis Data from Phosphorus Carrier Study on Tall Fescue for 1974*

Element	Carrier	Treatment (lbs. P_2O_5/A) 0	60	120	180	240	Optimum Level (Percent)
		----------	----------	%	----------	----------	
Nitrogen	MAP	2.02	1.94	2.00	2.04	2.08	3.00
	TSP	1.94	1.98	1.92	1.98	1.98	
Phosphorus	MAP	.57	.46	.52	.52	.54	.30
	TSP	.47	.63	.79	.81	.88	
Potassium	MAP	3.07	2.70	2.78	2.81	2.61	2.50
	TSP	2.55	3.23	3.11	3.17	2.82	
Calcium	MAP	.54	.51	.45	.62	.53	.20
	TSP	.44	.64	.59	.64	.56	
Magnesium	MAP	.53	.47	.48	.53	.54	.20
	TSP	.46	.55	.59	.55	.57	
		----------	----------	ppm	----------	----------	
Manganese	MAP	210	165	172	317	262	50
	TSP	149	191	217	208	202	
Iron	MAP	91	106	79	88	85	50
	TSP	85	91	103	98	101	
Boron	MAP	8	8	8	9	10	6
	TSP	11	9	10	9	10	
Copper	MAP	10	9	8	9	9	3
	TSP	10	11	13	11	12	
Zinc	MAP	27	23	23	26	29	20
	TSP	26	26	30	27	28	

* Top growth collected on July 14, 1974

Table 6. Plant Analysis Data from Phosphorus Carrier Study on Tall Fescue for 1974*

Element	Carrier	Treatment (lbs. P_2O_5/A) 0	60	120	180	240	Optimum Level (Percent)
		----------	----------	%	----------	----------	
Nitrogen	MAP	1.61	1.61	1.59	1.60	1.54	3.00
	TSP	1.60	1.57	1.58	1.68	1.60	
Phosphorus	MAP	.29	.36	.36	.37	.44	.35
	TSP	.31	.43	.43	.43	.47	
Potassium	MAP	2.26	2.27	2.26	2.39	2.13	2.50
	TSP	2.32	2.19	2.33	2.70	2.47	
Calcium	MAP	.34	.41	.38	.45	.46	
	TSP	.41	.40	.38	.40	.39	
Magnesium	MAP	.29	.31	.32	.38	.38	.20
	TSP	.33	.35	.32	.29	.32	
		----------	----------	ppm	----------	----------	
Manganese	MAP	85	78	66	116	124	50
	TSP	66	66	75	70	82	
Iron	MAP	79	85	79	85	99	50
	TSP	84	88	88	82	91	
Boron	MAP	8	9	9	9	10	6
	TSP	10	11	10	10	10	
Copper	MAP	7	8	9	8	8	3
	TSP	7	8	9	8	7	
Zinc	MAP	17	19	18	20	22	20
	TSP	18	18	18	19	19	

* Top growth collected October 10, 1974

Soil Analyses

Soil Samples were collected on October 7, obtaining five soil cores from each plot treatment and then combining the twenty from four replications for a composite sample.

Three depths of soil, 0-1", 1-2", and 2-3" were separated at the time each plug was drawn. Table 7 illustrates the localization of phosphorus and potassium to the top inch of surface soil. In Table 8, additional data showing magnesium, manganese and zinc levels are listed. Soil magnesium levels are relatively constant and it is assumed that small quantities applied would not make a significant change.

For economic reasons, tests for manganese and zinc were limited to surface samples. Soil analytical procedures used were more effective in detecting different levels of zinc applied than for manganese. Soil samples where manganese and zinc levels are not currently available have been stored for future use, if requested.

Table 7. Soil Test Data from Phosphorus Study on Tall Fescue

Trt. (lbs P_2O_5/A	Soil Depth (in.)	MAP	TSP	MAP	TSP	MAP	TSP
		---- pH ----		---- ppm P----		---- ppm K ----	
0	0-1	6.2	6.1	6	5	205	150
	1-2	6.5	6.2	3	2	97	82
	2-3	6.5	6.5	2	3	67	60
60	0-1	6.3	6.2	5	13	142	187
	1-2	6.4	6.3	3	3	97	90
	2-3	6.6	6.3	2	3	67	60
120	0-1	6.2	6.2	9	15	187	157
	1-2	6.4	6.2	3	3	97	90
	2-3	6.7	6.7	3	4	67	60
180	0-1	6.1	6.3	9	26	120	150
	1-2	6.3	6.6	3	5	82	82
	2-3	6.5	6.6	1	2	60	60
240	0-1	6.1	6.2	12	36	127	150
	1-2	6.3	6.4	3	9	75	97
	2-3	6.5	6.6	2	3	67	67
Averages by depth:							
	0-1	6.2	6.2	8	19	156	159
	1-2	6.4	6.3	3	4	89	88
	2-3	6.6	6.5	2	3	66	61

Samples collected: October 7, 1974

Phosphorus values for top inch of soil reflect treatment applications but not in a [illegible]raight line increase. There is a possibility from the outcome of these tests [illegible] MAP was more available for plant uptake due to adequate soil moisture than the

Table 8. Soil Test Data from Phosphorus Study on Tall Fescue

Trt. (lbs P_2O_5/A	Soil Depth (in.)	MAP	TSP	MAP	TSP	MAP	TSP
		----ppm Mg ----		---- ppm Mn ----		---- ppm Zn ----	
0	0-1	260	250	42	-	3.0	-
	1-2	250	220	-	-	-	-
	2-3	230	210	-	-	-	-
60	0-1	210	250	67	-	3.5	-
	1-2	220	260	-	-	-	-
	2-3	230	240	-	-	-	-
120	0-1	240	250	57	-	4.0	-
	1-2	230	230	-	-	-	-
	2-3	230	230	-	-	-	-
180	0-1	190	230	52	-	5.5	-
	1-2	230	210	-	-	-	-
	2-3	230	210	-	-	-	-
240	0-1	240	230	57	40	6.5	2.9
	1-2	230	240	-	-	-	-
	2-3	230	230	-	-	-	-
Averages by depth:							
	0-1	228	242	55	40	4.5	2.9
	1-2	234	232	-	-	-	-
	2-3	230	224	-	-	-	-

Samples collected: October 7, 1974

This data shows no change in magnesium or manganese levels by treatments applied. A linear change was observed for zinc. Only surface samples were processed for Mn and Zn to reduce analytical expense.

SUMMARY

1. Two materials, magnesium-ammonium-phosphate, and triple superphosphate, were applied to established tall fescue sod for comparison as fertilizer material.

2. An overseeding of Korean Lespedeza was broadcast over undisturbed tall fescue sod as an evaluator for two phosphorus fertilizers, one a suspension and one a granular material.

3. Extremely heavy top growth resulted from the fescue treated with the higher rates of MAP. Nitrogen totalled 108 lbs/A while 300 lbs P_2O_5/A as MAP was applied.

4. Lespedeza seedling emergence was quite promising even at the higher MAP rates in late May. However, a delay in mowing operations and aftermath removal was extremely damaging as evident from legume stand counts. Plots receiving little or no nitrogen contained the denser stands of Korean Lespedeza.

5. Plant analysis data were reported for three sampling dates. Nutrient deficiencies were most evident for nitrogen and zinc. It was also interesting to note zinc levels for first and third cutting, well below an "adequate" level particularly where TSP had been used.

6. Spring applications of both MAP and TSP were detectable in soil samples collected in October.

7. The first increment of soil, 0-1", showed appreciable gains in soi P and K with progressively higher rates. Buildup, or increased P readings were most evident where TSP was applied. Cause for this occurence is not clear, whether phosphorus complexes from MAP were not adequately measured by the soil test, or whether a more substantial portion had been drawn off by plant root uptake, and basal growth which measured 24" in height on May 24. Corresponding tissue from TSP measured only 12".

8. A positive linear trend was observed from zinc soil test data on MAP plots. Plant needs and/or availability was not adequate as supported by plant analysis concentrations for zinc.

9. Manganese levels were higher on plots receiving 60 lbs P_2O_5 or more as MAP in the 1st cutting, and appreciably higher in the second and third where 180 or 240 lbs P_2O_5 was used.

10. The most pronounced observations derived from the first year's work on this study was tall fescue response to MAP as a nitrogen source. Because this element is no longer available in quantity for 1975, a more dramatic expression should be seen from the lespedeza seed yet to germinate and grow, a trait of legumes having seed with hard seed coats.

Phosphorus Study in Alfalfa

PROCEDURES

This study was initiated in July 1974, to obtain a more broader base for evaluating the magnesium-ammonium-phosphate as a fertilizer material. Alfalfa was selected as a second test crop since its fertility requirements are high, possesses a perennial growth habit, and is used extensively as a forage crop.

An established alfalfa field near the U.S. Weather Station at SIPAC was obtained for use in this study. The soil fertility level was low, a prerequisite for the evaluations proposed, and the stand was adequate for 2-3 years of research.

Soils Information

Soil Type: Zanesville silt loam, a relatively flat soil with good surface drainage but poor internal drainage, due to a compacted clay layer in the subsoil.

Soil Test Data:	Soil-water pH:	5.7-6.3 (low)
	Phosphorus:	9 ppm (very low)
	Potassium:	60 ppm (very low)
	Calcium:	2020 ppm (low)
	Magnesium:	140 ppm (low)

Experimental Information

Design: split plot, with phosphorus carriers assigned to main plots, and rates of application assigned to subplots.

Plot Size: 5 feet by 8 feet, or .001 acre.

Replications: three

Treatments: magnesium-ammonium-phosphate, 3.78% P, suspension.
triple superphosphate, 19.78% P, granular.

Treatment Rates: 0 (check), 60, 120, 180, 240 and 300 lbs. P_2O_5/A.

Date of Application: July 14, 1974.

On July 14, a standing hay crop was removed to facilitate plot layout and application of treatments.

A broadcast application equivalent to 600 lbs. muriate of potash/acre or 360 lbs. K_2O/acre, was applied.

Phosphorus treatments as described for the fescue study were completed according to the field diagram in Figure 1.

On August 15, Gilliam and Hood inspected the site for treatment effect and need for plant tissue sampling. Because only one month had elapsed from nutrient application, it was decided to have the cutting removed at bloom and plan to sample the regrowth in late September, or early October.

Plant and soil samples were collected on October 7, and the results of these analyses appear in Tables 9, 10, 11 and 12.

Figure 1. Experimental Plot Diagram of Phosphorus Study on Alfalfa, SIPAC

N

MAP						TSP					
300	180	60	240	120	0	300	180	60	240	120	0
TSP						MAP					
240	120	300	0	60	180	240	120	300	0	60	180
MAP						TSP					
0	60	120	180	240	300	0	60	120	180	240	300

MAP - Magnesium-ammonium-phosphate

TSP - Triple superphosphate

Rates: 0, 60, 120, 180, 240 and 300 lbs. P_2O_5/A.

Results

PLANT ANALYSES

The results from the first series of alfalfa tissue analyses appearing in Table 9 show several elements to be deficient, even though a portion of these conditions were predictable by the initial soil test.

An optimum level for each element has been shown in the right hand column. This figure has been drawn from what might be termed an "adequate range" for each element.

All values for N, P and K were within range. No definite trends are evident from phosphorus data, and the short interval between application and test may explain this condition.

Low values for calcium and magnesium reflect need for lime plus cation balance tipped toward potassium by the liberal application.

Manganese suggests a response to the material applied in MAP.

Iron was very adequate, while copper and boron appear in short supply to require a top dressing in advance of 1975. Zinc levels show no consistent trends to imply favorable benefit derived from MAP source.

Soil Tests

Procedures described for soil sampling on the fescue study were followed here, except that a composite from three replicates occurred instead of four.

These data show the significance of shallow increments of soil in quantifying soil fertility.

Table 9. Plant Analysis Data from Phosphorus Study on Alfalfa for 1974*

Element	Carrier	Treatment (lbs. P_2O_5/A) 0	60	120	180	240	300	Optimum Level Percent
		%						
Nitrogen	MAP	4.24	4.63	4.34	4.08	4.52	5.17	4.00
	TSP	4.64	4.16	4.53	4.42	4.21	4.16	
Phosphorus	MAP	0.50	0.42	0.45	0.38	0.39	0.42	0.30
	TSP	0.43	0.42	0.41	0.39	0.60	0.43	
Potassium	MAP	2.78	2.91	3.07	2.91	2.74	2.81	2.50
	TSP	2.84	2.71	3.25	2.73	3.20	2.82	
Calcium	MAP	1.62	1.36	1.55	1.30	1.48	1.26	1.80
	TSP	1.34	1.52	1.41	1.33	1.62	1.38	
Magnesium	MAP	0.32	0.27	0.35	0.28	0.33	0.30	0.30
	TSP	0.26	0.29	0.29	0.27	0.32	0.29	
		ppm						
Manganese	MAP	81	76	166	103	172	220	70
	TSP	60	87	78	71	73	69	
Iron	MAP	225	197	235	190	188	159	150
	TSP	182	204	165	197	218	176	
Boron	MAP	25	20	21	19	20	18	40
	TSP	19	19	19	16	21	18	
Copper	MAP	20	13	15	14	14	12	20
	TSP	13	13	12	14	16	12	
Zinc	MAP	40	31	37	32	38	39	30
	TSP	31	29	31	29	33	28	

Treatments applied: July 14, 1974

* Top 6 inches of stems collected October 10, 1974

Table 10.

Soil Phosphorus Tests from Alfalfa Study

at SIPAC, 1974

Soil Depth	Carrier	0	60	120	180	240	300	AV
		lbs. P_2O_5/A						
		ppm P						
0-1"	MAP	17	24	40	82	75	94	55
	TSP	20	55	52	92	108	195	87
1-2"	MAP	14	11	14	16	16	20	15
	TSP	14	15	18	25	17	20	18
2-3"	MAP	9	13	11	11	15	12	12
	TSP	12	12	13	12	10	17	13

Samples collected: October 7, 1974

In Table 10, both phosphorus carriers were effective in raising the phosphorus level of the 0-1" increment, if not a deeper depth. Potassium results in Table 11, show the heavy impact of a broadcast application of potassium chloride on surface fertility. Magnesium levels were unchanged by treatments applied, as shown in Table 12, while manganese values were inconclusive, when considering check sample results for MAP (87) and TSP test of 46 where manganese was not applied.

Zinc levels reflect applied rates, increasing from 0.7 ppm on "0" treatment to 7.5 ppm on the "300 lb." rate.

Voids in manganese and zinc data were intentional, since effect of dilute suspensions should be localized.

Table 11. 1974 Soil Test Data from Phosphorus Study on Alfalfa

Trt. (lbs P_2O_5/A)	Soil Depth (in.)	MAP	TSP	MAP	TSP
		---- pH -----		--- ppm K ---	
0	0-1	6.0	6.0	525	470
	1-2	6.2	6.1	187	225
	2-3	6.4	6.2	90	97
60	0-1	5.9	5.9	505	470
	1-2	6.1	6.0	205	170
	2-3	6.4	6.2	96	75
120	0-1	5.8	5.9	525	505
	1-2	6.0	6.1	187	205
	2-3	6.4	6.3	82	90
180	0-1	5.5	6.0	562	450
	1-2	5.9	6.1	262	205
	2-3	6.2	6.2	105	82
240	0-1	5.4	5.9	505	430
	1-2	5.8	6.1	225	170
	2-3	6.2	6.3	97	82
300	0-1	5.5	5.9	562	450
	1-2	5.4	6.0	262	170
	2-3	6.1	6.1	112	90
Averages by depth	0-1	5.7	5.9	536	457
	1-2	5.9	6.1	225	191
	2-3	6.3	6.2	97	86

Samples Collected: October 7, 1974

Table 12. 1974 Soil Test Data from Phosphorus Study on Alfalfa

Magnesium:

Soil Depth (in.)	Carrier	0	60	120	180	240	300	AV
		lbs. P_2O_5/A						
		ppm Mg						
0-1"	MAP	166	184	174	178	196	196	182
	TSP	162	162	172	162	166	172	166
1-2"	MAP	190	180	168	170	178	176	177
	TSP	170	186	172	182	192	186	181
2-3"	MAP	172	192	180	196	170	198	185
	TSP	180	174	174	178	108	164	176

Manganese:

Soil Depth (in.)	Carrier	0	60	120	180	240	300	AV
0-1" *	MAP	87	64	96	84	84	87	84
	TSP	-	-	-	-	-	46	46

Zinc:

Soil Depth (in.)	Carrier	0	60	120	180	240	300	AV
0-1" *	MAP	0.7	2.8	3.9	9.1	7.2	7.5	5.2
	TSP	-	-	-	-	-	1.1	1.1

* Only surface samples were analyzed for manganese and zinc.

SUMMARY

1. Magnesium-ammonium-phosphate was surface applied to an established alfalfa stand at SIPAC in July 1974. Comparative material for the MAP suspension was granular triple superphosphate broadcast at corresponding rates as part of a split plot experiment.

2. The selected site was moderately acid in pH (5.7-6.3), very low in P (9ppm), and very low in K (60 ppm). Soil calcium and magnesium were also low.

3. An initial application of muriate of potash equivalent to 600 lbs/A was broadcast to supply crop needs thru 1975.

4. Phosphorus rates comprising the study are 0, 60, 120, 180, 240 and 300 lbs P_2O_5/acre.

5. Plant analyses data were obtained from samples collected on October 7, 1974.

6. Several deficiencies were detected...calcium, magnesium, copper and boron which could be limiting alfalfa response to phosphorus in 1975, unless corrected.

7. Manganese levels were higher under MAP treatments than where TSP was applied. Plant response to the manganese component was evident in alfalfa receiving 120 lbs. P_2O_5 and higher.

8. Impact of fertilizer treatments on soil test levels were most evident in the first increment, 0-1" depth, specifically for both phosphorus carriers and potassium.

9. Zinc applied as part of the MAP suspension was effective in raising soil test levels similar to the trend observed within the fescue series.

10. Several aspects of this study would justify a continuation of the work. Evaluation of alfalfa response to MAP would be premature at this time. Corrective measures to alleviate other deficiencies, namely calcium, magnesium, copper and boron would create more ideal circumstances for obtaining a true phosphorus response.